

CLAIMS

We claim:

1. A method of tagging results of an XML query over a relational database, said method
- 2 comprising:
- 3 generating a tagger tree graph from said XML query, each node of said tagger tree
- 4 graph comprising a tagger operator, each tagger operator having a parse tree associated therewith;
- 5 calling each tagger operator in accordance with a structure of said tagger tree
- 6 graph, and
- 7 evaluating said parse trees associated with each called tagger operator to tag
- 8 results of said XML query over said relational database.

1 2. A method of tagging results of an XML query over a relational database, as per claim 1,
2 wherein said tagger node graph has a top-most tagger operator and a plurality of lower-most
3 tagger operators, said calling and evaluating steps further comprising:

4 a. starting with said top-most tagger operator, each tagger operator implementing
5 a method to request results from inputs to said tagger operator, said method causing lower-level
6 tagger operators connected to said inputs to be called;

7 b. starting with said lower-most tagger operators, each called tagger operator
8 returning intermediate tagged results to a higher-level connected tagger operator upon evaluating
9 said associated parse tree;

10 performing steps a and b until an end of said results of said XML query is
11 reached, and

12 said top-most tagger operator producing tagged output XML of said results of said
13 XML query.

14 3. A method of tagging results of an XML query over a relational database, as per claim 1,
15 wherein said tagger operators comprise any of a tagger input operator, a tagger scalar operator or
16 a tagger aggregate operator.

1 4. A method of tagging results of an XML query over a relational database, as per claim 1,
2 wherein said tagger graph includes a tagger input operator for each level in a result XML tree of
3 said XML query.

1 5. A method of tagging results of an XML query over a relational database, as per claim 4,
2 wherein said tagger input operators execute in a sorted outer union mode.

1 6. A method of tagging results of an XML query over a relational database, as per claim 5,
2 wherein said tagger input operators comprise a shared tagger row stream.

1 7. A method of tagging results of an XML query over a relational database, as per claim 4,
2 wherein said tagger input operators execute in a node strip mode.

1 8. A method of tagging results of an XML query over a relational database, as per claim 7,
2 wherein each of said tagger operators comprises a tagger row stream.

1 9. A method of tagging results of an XML query over a relational database, as per claim 1,
2 wherein each tagger operator performs any of a cr8_elem, a cr8_attr, a cr8_attr_list, a
3 cr8_fragments or a cr8_fragment_list function.

1 10. A method of tagging results of an XML query over a relational database, as per claim 1,
2 wherein each tagger operator implements a next method to produce a result row.

1 11. A method of tagging results of an XML query over a relational database, as per claim 1,
2 said method further comprising:

3 parsing said XML query;

4 transforming said XML queries into a language-neutral intermediate
5 representation;

6 rewriting said language-neutral intermediate representation into an equivalent
7 form easily translated into an SQL query;

8 translating said equivalent form into one or more SQL queries over said relational
9 database, and

10 executing said one or more SQL queries to produce said results of said XML
11 query over said relational database.

1 12. A method of tagging results of an XML query over a relational database, as per claim 11,
2 wherein said tagger graph is generated from said equivalent form.

1 13. A method of tagging results of an XML query over a relational database, as per claim 11,
2 wherein said tagger graph includes a tagger input operator for each node in a result XML tree of
3 said XML query.

1 14. A method of tagging results of an XML query over a relational database, as per claim 13,
2 wherein said tagger input operators execute in a sorted outer union mode and said translating step
3 produces a single SQL query to produce a single sorted outer union relational database result.

1 15. A method of tagging results of an XML query over a relational database, as per claim 14,
2 wherein said tagger input operators comprise a shared tagger row stream.

1 16. A method of tagging results of an XML query over a relational database, as per claim 13,
2 wherein said tagger input operators execute in a node strip mode and said translating step
3 produces a set of SQL queries to produce a set of node strip relational database results.

1 17. A method of tagging results of an XML query over a relational database, as per claim 16,
2 wherein each of said tagger operators comprises a tagger row stream.

1 18. A method of tagging results of an XML query over a relational database, as per claim 11,
2 wherein said tagger operators comprise any of a tagger input operator, a tagger scalar operator or
3 a tagger aggregate operator.

1 19. A method of tagging results of an XML query over a relational database, as per claim 11,
2 wherein a number of relational database tables of said relational database are mapped to a
3 number of virtual XML documents and said XML queries are issued over said virtual XML
4 documents.

20. A method of tagging results of an XML query over a relational database, as per claim 1,
wherein said method operates over a distributed computing network.

21. A method of tagging results of an XML query over a relational database, as per claim 20,
wherein said method operates over the Internet.

1 22. A system for tagging results of an XML query over a relational database, said system
2 comprising:

3 a tagger runtime;

4 a tagger tree graph generated from said XML query, each node of said tagger tree
5 graph comprising a tagger operator;

6 a parse tree associated with each tagger operator, and

7 wherein said tagger runtime calls each tagger operator in accordance with a
8 structure of said tagger tree graph and evaluates said parse trees associated with each called
tagger operator to tag results of said XML query over said relational database.

1 23. A system for tagging results of an XML query over a relational database, as per claim 22,
2 wherein said tagger node graph has a top-most tagger operator and a plurality of lower-most
3 tagger operators, and to perform said calling and evaluating, said tagger runtime further:

4 a. starting with said top-most tagger operator, causing each tagger operator to
5 implement a method to request results from inputs to said tagger operator, said method causing
6 lower-level tagger operators connected to said inputs to be called;

7 b. starting with said lower-most tagger operators, causing each called tagger
8 operator to return intermediate tagged results to a higher-level connected tagger operator upon
9 evaluating said associated parse tree;

10 performing steps a and b until an end of said results of said XML query is
11 reached, and

12 upon reaching an end of said results of said XML query, causing said top-most
13 tagger operator to produce a tagged output XML document of said results of said XML query.

14 24. A system for tagging results of an XML query over a relational database, as per claim 22,
15 wherein said tagger operators comprise any of a tagger input operator, a tagger scalar operator or
16 a tagger/aggregate operator.

1 25. A system for tagging results of an XML query over a relational database, as per claim 22,
2 wherein said tagger graph includes a tagger input operator for each node in a result XML tree of
3 said XML query.

1 26. A system for tagging results of an XML query over a relational database, as per claim 25,
2 wherein said tagger input operators execute in a sorted outer union mode.

1 27. A system for tagging results of an XML query over a relational database, as per claim 26,
2 wherein said tagger input operators comprise a shared tagger row stream.

1 28. A system for tagging results of an XML query over a relational database, as per claim 25,
2 wherein said tagger input operators execute in a node strip mode.

1 29. A system for tagging results of an XML query over a relational database, as per claim 28,
2 wherein each of said tagger operators comprises a tagger row stream.

1 30. A system for tagging results of an XML query over a relational database, as per claim 22,
2 wherein each tagger operator performs any of a cr8_elem, a cr8_attr, a cr8_attr_list, a
3 cr8_fragments or a cr8_fragment_list function.

1 31. A system for tagging results of an XML query over a relational database, as per claim 22,
2 wherein each tagger operator implements a next method to produce a result row.

1 32. A system for tagging results of an XML query over a relational database, as per claim 22,
2 said system further comprising:

3 a parser, said parser parsing said XML query and transforming said XML queries
4 into a language-neutral intermediate representation;

5 a rewrite engine, said rewrite engine rewriting said language-neutral intermediate
representation into an equivalent form easily translated into an SQL query;

6 a translator, said translator translating said equivalent form into one or more SQL
7 queries over said relational database, and
8

9 an RDBMS, said RDBMS executing said one or more SQL queries to produce
10 said results of said XML query over said relational database.
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12 33. A system for tagging results of an XML query over a relational database, as per claim 32,
13 wherein said tagger graph is generated from said equivalent form.
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1 34. A system for tagging results of an XML query over a relational database, as per claim 32,
2 wherein said tagger graph includes a tagger input operator for each node in a result XML tree of
3 said XML query.

1 35. A system for tagging results of an XML query over a relational database, as per claim 34,
2 wherein said tagger input operators execute in a sorted outer union mode and said translator
3 produces a single SQL query to produce a single sorted outer union relational database result.

1 36. A system for tagging results of an XML query over a relational database, as per claim 35,
2 wherein said tagger input operators comprise a shared tagger row stream.

1 37. A system for tagging results of an XML query over a relational database, as per claim 34,
2 wherein said tagger input operators execute in a node strip mode and said translator produces a
3 set of SQL queries to produce a set of node strip relational database results.

1 38. A system for tagging results of an XML query over a relational database, as per claim 37,
2 wherein each of said tagger operators comprises a tagger row stream.

1 39. A system for tagging results of an XML query over a relational database, as per claim 32,
2 wherein said tagger operators comprise any of a tagger input operator, a tagger scalar operator or
3 a tagger aggregate operator.

1 40. A system for tagging results of an XML query over a relational database, as per claim 32,
2 said system further comprising:

3 a schema mapper, said schema mapper mapping a number of relational database
4 tables of said relational database to a number of virtual XML documents, and

5 an XML-QL engine, said XML-QL engine issuing said XML queries over said
6 virtual XML documents.

1 41. A system for tagging results of an XML query over a relational database, as per
claim 22, wherein said system operates over a distributed computing network.

2 42. A system for tagging results of an XML query over a relational database, as per
claim 41, wherein said system operates over the Internet.

3 43. A system for tagging results of an XML query over a relational database, as per
claim 22, wherein said tagger runtime operates outside an RDBMS.

1 44. A system for tagging results of an XML query over a relational database, said system
2 comprising:

3 means for generating a tagger tree graph from said XML query, each node of said
4 tagger tree graph comprising a tagger operator, each tagger operator having a parse tree
5 associated therewith;

6 means for calling each tagger operator in accordance with a structure of said
7 tagger tree graph, and

8 means for evaluating said parse trees associated with each called tagger operator
9 to tag results of said XML query over said relational database.

10 45. A computer program product comprising a machine-readable medium including
1 computer readable program code therein for tagging results of an XML query over a relational
2 database comprising:

3 computer readable program code generating a tagger tree graph from said XML
4 query, each node of said tagger tree graph comprising a tagger operator, each tagger operator
5 having a parse tree associated therewith;

6 computer readable program code calling each tagger operator in accordance with a
7 structure of said tagger tree graph, and

8 computer readable program code evaluating said parse trees associated with each
9 called tagger operator to tag results of said XML query over said relational database.

1 46. A computer program product comprising a machine-readable medium including
2 computer readable program code therein for tagging results of an XML query over a relational
3 database as per claim 45, wherein said generated tagger node graph has a top-most tagger
4 operator and a plurality of lower-most tagger operators, said calling and evaluating computer
5 readable program code further comprising:
6 computer readable program code for performing:
7 a. starting with said top-most tagger operator, each tagger operator requesting
8 results from inputs to said tagger operator, said request causing lower-level tagger operators
9 connected to said inputs to be called;
10 b. starting with said lower-most tagger operators, each called tagger operator
11 returning intermediate tagged results to a higher-level connected tagger operator upon evaluating
12 said associated parse tree;
13 performing steps a and b until an end of said results of said XML query is
14 reached, and
15 said top-most tagger operator producing tagged output XML of said results of said
16 XML query.